ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

93000836 - Microelectronic Technology

DEGREE PROGRAMME

09AQ - Master Universitario en Ingenieria de Telecomunicacion

ACADEMIC YEAR & SEMESTER

2020/21 - Semester 2

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	93000836 - Microelectronic Technology
No of credits	6 ECTS
Type	Optional
Academic year ot the programme	Second year
Semester of tuition	Semester 4
Tuition period	February-June
Tuition languages	English
Degree programme	09AQ - Master Universitario en Ingenieria de Telecomunicacion
Centre	09 - Escuela Tecnica Superior de Ingenieros de Telecomunicacion
Academic year	2020-21

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Jimena Olivares Roza (Subject coordinator)	B-307	jimena.olivares@upm.es	Sin horario. Tutorial appointments will be fixed by e-mail
Marta Clement Lorenzo	B-307	marta.clement@upm.es	Sin horario. Tutorial appointments will be fixed by e-mail

Jesus Sangrador Garcia	B-308	jesus.sangrador@upm.es	Sin horario. Tutorial appointments will be fixed by e-mail

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

The subject - recommended (passed), are not defined.

3.2. Other recommended learning outcomes

- Basic physics and thermodynamics. Basic electricity and magnetism

- Basic knowledge of semiconductors and device physics

4. Skills and learning outcomes *

4.1. Skills to be learned

CE10 - Capacidad para diseñar y fabricar circuitos integrados.

CE15 - Capacidad para la integración de tecnologías y sistemas propios de la Ingeniería de Telecomunicación, con carácter generalista, y en contextos más amplios y multidisciplinares como por ejemplo en bioingeniería, conversión fotovoltaica, nanotecnología, telemedicina.

CG2 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.

CG4 - Que los estudiantes sepan comunicar sus conclusiones ?y los conocimientos y razones últimas que las sustentan? a públicos especializados y no especializados de un modo claro y sin ambigüedades.

CG5 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un

modo que habrá de ser en gran medida autodirigido o autónomo.

CT1 - Capacidad para comprender los contenidos de clases magistrales, conferencias y seminarios en lengua inglesa.

CT3 - Capacidad para adoptar soluciones creativas que satisfagan adecuadamente las diferentes necesidades planteadas.

CT4 - Capacidad para trabajar de forma efectiva como individuo, organizando y planificando su propio trabajo, de forma independiente o como miembro de un equipo.

CT5 - Capacidad para gestionar la información, identificando las fuentes necesarias, los principales tipos de documentos técnicos y científicos, de una manera adecuada y eficiente.

4.2. Learning outcomes

RA122 - Conocer a nivel básico los procesos tecnológicos que se usan en la fabricación de circuitos integrados

RA125 - Conocer las aplicaciones de las tecnologías microelectrónicas a dispositivos electrónicos particulares como dispositivos pasivos de alta frecuencia, sensores, MEMS, etc.

RA124 - Conocer el concepto de tecnología de fabricación microelectrónica y saber diseñar esquemáticamente una ruta de fabricación de CI

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

In the subject Microelectronic Technology the students will deal with technologies currently used in the microfabrication of integrated circuits. The concept of technology is introduced as a concatenation of technological processes. Each individual process is described together with concepts about integration by highlighting the importance of their interrelation to build a complete technology.

The main objective is that the students become familiar with processes involved in the microfabrication of ICs and with the fabrication technologies used currently.

5.2. Syllabus

1. Schedule and module rules

2. Introduction

3. Technological processes I (Lithography and etching)

4. Device fabrication technology

5. Technological processes II (Materials, thermal oxidation, ion implantation)

6. Vacuum technologies

7. Deposition techniques I (Thermal evaporation)

8. Deposition techniques II (Sputtering)

9. Deposition techniques III (CVD)

6. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Distant / On-line	Assessment activities
1	**Introduction** Duration: 02:00 Lecture			
2	**Topic 1** Duration: 02:00 Lecture			
3	**Topic 2** Duration: 02:00 Lecture	**Practical session 1: Simulation of the technology** Duration: 03:00 Laboratory assignments		**Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.** Individual work Continuous assessment Not Presential Duration: 00:00
4	**Topic 3** Duration: 02:00 Lecture	**Practical session 2** Duration: 03:00 Laboratory assignments		**Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.** Individual work Continuous assessment Not Presential Duration: 00:00
5	**Topic 4** Duration: 02:00 Lecture	**Practical session 3** Duration: 03:00 Laboratory assignments		**Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.** Individual work Continuous assessment Not Presential Duration: 00:00
6	**Tema 5** Duration: 02:00 Lecture	**Practical session 4** Duration: 03:00 Laboratory assignments		**Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.** Individual work Continuous assessment Not Presential Duration: 00:00

7	**Topic 6** Duration: 02:00 Lecture	**Practical session 5** Duration: 03:00 Laboratory assignments		**Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.** Individual work Continuous assessment Not Presential Duration: 00:00
8	**Visit to the ion implanter at CAI de Técnica Físicas of UCM** Duration: 02:00 Additional activities			**Test 1** Written test Continuous assessment Presential Duration: 01:00
9	**Topic 7** Duration: 02:00 Lecture	**Practical session 6** Duration: 03:00 Laboratory assignments		**Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.** Individual work Continuous assessment Not Presential Duration: 00:00
10	**Topic 8** Duration: 02:00 Lecture	**Sesión práctica 7** Duration: 03:00 Laboratory assignments		**Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.** Individual work Continuous assessment Not Presential Duration: 00:00
11	**Topic 9** Duration: 02:00 Lecture	**Practical session 8** Duration: 03:00 Laboratory assignments		**Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.** Individual work Continuous assessment Not Presential Duration: 00:00
12		**Practical session 9** Duration: 03:00 Laboratory assignments		**Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.** Individual work Continuous assessment Not Presential Duration: 00:00

13	**Assistance to the oral presentation session** Duration: 04:00 Additional activities			**Oral presentation** Individual presentation Final examination Presential Duration: 00:30 **Oral presentation** Individual presentation Continuous assessment Presential Duration: 00:20
14				
15				**Test 2** Written test Continuous assessment Presential Duration: 02:00
16				
17				**Test** Written test Final examination Presential Duration: 03:00

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
3	Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.	Individual work	No Presential	00:00	10%	4 / 10	CG2 CT5 CG4 CT1 CT4 CT3 CG5 CE10 CE15
4	Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.	Individual work	No Presential	00:00	%	4 / 10	
5	Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.	Individual work	No Presential	00:00	%	4 / 10	
6	Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.	Individual work	No Presential	00:00	%	4 / 10	
7	Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.	Individual work	No Presential	00:00	%	4 / 10	

8	Test 1	Written test	Face-to-face	01:00	30%	4 / 10	CT1 CT3 CE10
9	Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.	Individual work	No Presential	00:00	%	4 / 10	
10	Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.	Individual work	No Presential	00:00	%	4 / 10	
11	Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.	Individual work	No Presential	00:00	%	4 / 10	
12	Writing of a lab notebook to summarize the processes undertaken during each session, incluiding simulation, fabrication and characterization. The grade of this activity will be obtained as an average of the whole module.	Individual work	No Presential	00:00	%	4 / 10	
13	Oral presentation	Individual presentation	Face-to-face	00:20	20%	4 / 10	CT3 CE15
15	Test 2	Written test	Face-to-face	02:00	40%	4 / 10	CT3 CE15

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
13	Oral presentation	Individual presentation	Face-to-face	00:30	20%	4 / 10	CG4 CT3 CE15
17	Test	Written test	Face-to-face	03:00	80%	4 / 10	CG2 CT5 CT1 CT4 CG5 CE10

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Exam	Written test	Face-to-face	02:00	100%	5 / 10	CG2 CT5 CG4 CT1 CT4 CT3 CG5 CE10 CE15

7.2. Assessment criteria

Continuous evaluation

Mark required to pass the course: > 5/10 (Minimum mark in each part: 4/10). The assessable items are

Exam 1: 30%

Exam 2: 40%

Deliverables: 10

Oral presentation: 20%

* Attendance to lab sessions is mandatory. Absences must be duly justified.

Final exam

Students who choose the final exam option (or fail the continuous evaluation) must sit an exam (80% of the final mark) and give an oral presentation (20%) to pass the course.

Mark required in the final exam to pass the course: > 5/10 (Minimum mark in each part: 4/10)

* Attendance to lab sessions is mandatory. Absences must be duly justified.

Continuous evaluation is the default option.

For taking the final exam option, students must inform the coordinator in writing by the end of the third week of the module.

Extraordinary exam

Students who fail the continuous evaluation or the final exam must sit an exam to pass the course.

Mark required in the final exam to pass the course: > 5/10

* Attendance to lab sessions is mandatory. Absences must be duly justified.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Website of the module	Web resource	All relevant information of the module will be posted on its Moodle website.
Laboratorios de fabricación y caracterización de materiales y dispositivos	Equipment	Research lab conveniently adapted so that students can undertake the fabrication and characterization of MOS transistors with the supervision of a lecturer.

Handbook of Thin Film Technology. Frey, Hartmut, Khan, H. R. Springer (2015)	Bibliography	
Thin Films Material Technology: Sputtering of Compound Materials. Wasa, Kiyotaka, Kitabatake, Makoto, Adachi, Hideaki. Springer (2004)	Bibliography	
Sputtering Materials for VLSI and Thin Film Devices. Jaydeep Sarkar. Elsevier (2013)	Bibliography	
Thin Film Technology Handbook. Aicha Elshabini, Aicha Elshabini-Riad, Fred D. Barlow. McGraw Hill Professional, 1998	Bibliography	
Introduction to Surface and Thin Film Processes. John a. Venables. Cambridge U. Press. 2001	Bibliography	

9. Other information

9.1. Other information about the subject

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution. So, both teaching and evaluation activities may be converted to online activities if required by the health situation.

* This course invests a significant time and effort in laboratory activities. Since these activities take place in research facilities, small lab groups will be set at the beginning of the semester. The lab activities will be on morning sessions.

Communication with students

* Communication between students and lectures will be through e-mail and Moodle. Any question or concern about the module should be sent to the coordinator or any specific lecture by e-mail. The lectures will answer as soon as possible.

* Tutorials will take place face-to-face if possible or through Skype.

Platforms for online teaching

* Teams or Spype for business will be used for online teaching. Although if another platform is preferred by the majority of the lecturers of the master, that platform will be chosen.

Sustainable development goals

This module can contribute to Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all, in particular to targets 4.3 Ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university and 4.4 Substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.

As the module deals with microfabrication techniques for TIC components, we will have the opportunity to highlight Goal 9: Industry, Innovation and Infrastructure and its targets 9.5.Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending and 9.8 Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries.